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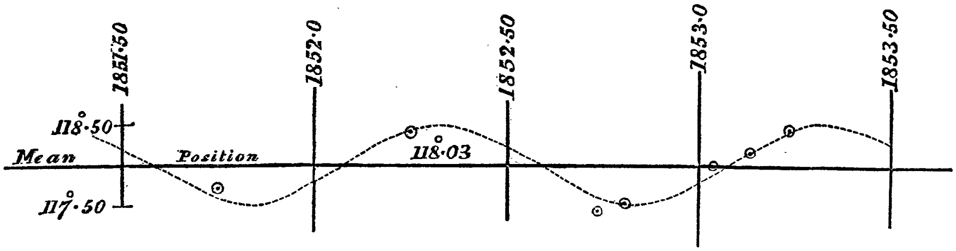
the highest the maker had furnished with his micrometer. The remainder were taken with a Dollond's micrometer (kindly lent by General Fraser), and with powers of 277 and 365. By far the greater number of observations were by daylight, or I doubt if they would have given such consistent results.

Epoch.	Position.	No. of Obs.	Distance.	No. of Obs.
	°		″	
1851·753	117·73	20	4·57	30
1852·252	118·43	25	4·45	30
·736	117·44	25	4·38	24
·801	117·59	35	4·60	42
1853·039	118·03	21	4·54	18
·127	118·13	23	4·63	24
·268*	118·52	26	4·46	26

" Epochs for greatest effect of parallax on the position, ·327 and ·835, or 30th April and 1st November.



" The dotted line is the curve corresponding to an annual parallax of 0″·059.

" *Observatory, Madras, April 12th*, 1853."

On the Determination of the Latitude of the Liverpool Observatory by means of Observations made in the Prime Vertical. By John Hartnup, Esq.

A short time subsequent to the establishment of the Liverpool Observatory, W. H. Simms, Esq., the present Surveyor-General of Ceylon, in a letter which I received from him, incidentally mentioned that he had been getting some observations on the prime vertical for latitude, and that he had found so convenient a formula for correcting the errors in the position of the transit instrument that he could apply it to all stars, whether high or low, with almost the same results. At my request he very kindly sent me the formula, and I applied it in the reduction of a series of observations taken with a transit placed nearly in the prime vertical, for the purpose of determining the latitude of the Liverpool Observatory. This formula has not, I believe, been published; and, with the permission of the author, I, therefore, beg to present it to the Royal Astronomical Society, together with fifty-eight results of co-latitude, in the reduction of which it has been employed.

The following are the formulæ which I received from Mr. Simms:—

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* Includes an additional observation taken this morning, 13th April.

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ϕ, the co-latitude of the place of observation.
π, the polar distance of a star observed on the east vertical.
π', — — — west vertical.
H, the hour-angle of the star observed east.
h, — — — west.
μ, the inclination of the axis of the instrument, positive when the south end is the highest.
ν, the azimuthal deviation from the prime vertical, supposed to be small.

$$\left.\begin{array}{l}\tan k = \tan \pi \,.\, \cos \mathrm{H} \\ \sin \psi = \sin \pi \,.\, \sin \mathrm{H}\end{array}\right\} \quad \left\{\begin{array}{l}\tan k' = \tan \pi' \,.\, \cos h \\ \sin \psi' = \sin \pi' \,.\, \sin h\end{array}\right.$$

$$\nu = \frac{\cos \psi \,.\, \cos \psi' \,.\, \tan (k'-k)}{\sin (\psi + \psi')}$$

$$\phi = k \pm \mu \pm \tan^{-1} (\nu \,.\, \tan \psi).$$

In the determination of the Valentia Arc of Longitude a very fine portable transit instrument of $3\frac{1}{2}$ feet focal length and $2\frac{1}{2}$ inches aperture, made by Troughton and Simms, was used at the Valentia station. The instrument is the property of the Rev. R. Sheepshanks, who very kindly allowed it, on its return from Ireland, to be left at the Liverpool Observatory for the purpose of determining the latitude by transits over the prime vertical.

A massive stone pier for the reception of the equatoreal was at that time erected; the walls of the equatoreal-room were built up, and a temporary covering of wood was thrown over the room. On this massive stone pier the portable transit stand was placed, and arrangements were made for me to walk around the instrument without stepping upon the pier. The transit instrument thus placed nearly in the prime vertical was within hearing of the sidereal clock, the error of which was determined by transits taken with the meridian transit instrument.

In order to give the method a fair trial I decided, previous to commencing the observations, that the following conditions should be complied with:—

1. That the time of taking each set of observations should not extend beyond an interval of a few hours; this was done with the view of guarding, as far as possible, against changes in the azimuthal position of the instrument.
2. That for each set, at least one star should be observed east, and one west, so that a good determination of the value of ν might be obtained.
3. That the instrument should be levelled as often as convenient during each set.
4. That every observation not made under favourable circumstances should be at once rejected, and not reduced.
5. That no observation made under favourable circumstances and reduced, should be rejected on the ground of discordance.

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Agreeably to the above conditions, 58 transits over the prime vertical were observed and reduced, 22 over the west, and 36 over the east vertical. Sixteen different stars were observed, whose north polar distances range from 38° to 66°, and the extreme difference in colatitude between either of the 58 results and the mean result is only 2″·66, and there are 31 of the 58 results which do not differ from the mean to the amount of one second of arc. The places of the stars were all taken from the Greenwich 12-year Catalogue.

The following example, which is added as a specimen of the calculation, will show the great convenience of the method. The three stars observed followed each other so closely that the whole time occupied in observing them did not extend over an interval of ten minutes, and the latitude deduced from these observations differs only from 0″·37 from the mean of the 58 results.

1845, *February* 6. *Illuminated End of Axis South.*

	12 *Can. Ven.*, W. h m s	β *Draconis*, E. h m s	γ *Draconis*, E. h m s
Observed Transits ……	16 19 53·37	16 25 24·00	16 28 41·60
Clock slow ……………	12·69	12·70	12·70
Transits corrected ……	16 20 6·06	16 25 36·70	16 28 54·30
App. R.A. of Stars……	12 48 48·04	17 26 55·23	17 52 59·64
Hour-Angle in Time …	3 31 18·02	1 1 18·53	1 24 5·34

$h = 52^\circ\ 49'\ 30''\cdot3$	$H = 15^\circ\ 19'\ 37''\cdot95$	$H = 21^\circ\ 1'\ 20''\cdot1$
$\pi' = 50\ 50\ 58\cdot7$	$\pi = 37\ 35\ 7\cdot0$	$\pi = 38\ 29\ 37\cdot0$

ν determined by 12 *Can. Ven.*, W., *and γ Draconis*, E.

$\tan \pi' = 0\cdot0893017$	$\sin \pi = 9\cdot9005058$	$k' = 36^\circ\ 34'\ 57''\cdot56$
$\cos h = 9\cdot7812169$	$\cos H = 9\cdot9700869$	$k = 36\ 35\ 14\cdot41$
$\tan k' = 9\cdot8705186$	$\tan k = 9\cdot8705927$	$k' - k = -16''\cdot85$
$\sin \pi' = 9\cdot889578$	$\sin \pi = 9\cdot794089$	$\cos \psi = 9\cdot988895$
$\sin h = 9\cdot901346$	$\sin H = 9\cdot554768$	$\cos \psi' = 9\cdot895560$
		$\tan k' - k = 5\cdot912175$
$\sin \psi' = 9\cdot790924$	$\sin \psi = 9\cdot348857$	$5\cdot796630$
		$\sin (\psi + \psi') = 9\cdot890905$
$\psi' = 38^\circ\ 9'\ 49''$	$\psi = 12^\circ\ 54'\ 7''$	$\log \nu = 5\cdot905725$

12 *Can. Ven.*

$k' = 36^\circ\ 34'\ 57''\cdot56$	$\tan \psi' = 9\cdot895364$
$\tan^{-1} (\nu\ .\ \tan \psi) = +\ 13\cdot05$	$\log \nu = 5\cdot905725$
$\mu = -\cdot85$	$5\cdot801089$
$\phi = 36\ 35\ 9\cdot76$	

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γ Draconis.

$$\begin{array}{rlrl}
k = & 36^\circ\;35'\;14''{\cdot}41 & \tan\psi = & 9{\cdot}359961 \\
\tan^{-1}(\nu\,.\,\tan\psi) = & -\;\;3{\cdot}80 & \log\nu = & \underline{5{\cdot}905725} \\
\mu = & \underline{\;\;\;-{\cdot}85} & & 5{\cdot}265686 \\
\phi = & 36\;\;35\;\;\;9{\cdot}76 & &
\end{array}$$

β Draconis.

$$\begin{array}{rlrlrl}
\tan\pi = & 9{\cdot}8863183 & \sin\pi = & 9{\cdot}785288 & \tan\psi = & 9{\cdot}213154 \\
\cos\,.\,\mathrm{H} = & \underline{9{\cdot}9842717} & \sin\mathrm{H} = & \underline{9{\cdot}422149} & \log\nu = & \underline{5{\cdot}905725} \\
\tan k = & 9{\cdot}8705900 & \sin\psi = & 9{\cdot}207437 & & 5{\cdot}118879 \\
k = & 36^\circ\;35'\;13''{\cdot}80 & \psi = & 9^\circ\;16'\;41'' & & \\
\tan^{-1}(\nu\,.\,\tan\psi) = & \;\;\;-2{\cdot}71 & & & & \\
\mu = & \underline{\;\;\;-{\cdot}85} & & & & \\
\phi = & 36\;\;35\;\;10{\cdot}24 & & & &
\end{array}$$

In the determination of ϕ in the above example, it has been assumed that the instrument was free from error of collimation. I had no means of determining the error of collimation except by observations of stars made with the illuminated end of the axis north and south alternately, and it was found to be desirable to observe sets in both positions of the instrument, over three, five, and sometimes seven wires, and consequently the collimation differed in these different sets. In the above example, the stars were observed over three wires, and the collimation for three wires, with the illuminated end of the axis south, was found to be $+2''{\cdot}73$, therefore $2''{\cdot}73$ must be added to the results in the above example.

When a star passes the prime vertical at 50° or 60° from the zenith, a small error either in the assumed place of the star or in the observed transit, will affect the latitude considerably; and as a general rule it may, perhaps, be desirable to use very low stars for the purpose of determining the azimuthal deviation only. The following table has been compiled from the partial results in order to show the resulting latitude from each star:—

	N.P.D.	Latitude.	No. of Obs.
	° ′	° ′ ″	
β Draconis	37 35	53 24 48·03	4
θ Ursæ Majoris	37 37	46·92	4
γ Draconis	38 29	48·15	4
η Ursæ Majoris	39 55	46·78	2
α Persei	40 42	46·49	10
ι Ursæ Majoris	41 22	46·83	1
Capella	44 10	47·72	6
β Aurigæ	45 5	48·65	1
α Cygni	45 16	47·59	4
12 Can. Ven.	50 51	47·54	4
α^2 Geminorum	57 47	48·17	3
ζ Cygni	60 24	48·34	5
β Tauri	61 32	48·88	4
β Geminorum.........	61 36	48·22	3
α Andromedæ	61 66	49·87	2
ε Leonis	65 31	48·68	1

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The mean latitude from all the observations = 53° 24′ 47″·72. The latitude of the transit instrument of the Liverpool observatory, by the Ordnance Survey, = 53° 24′ 46″·34 by the first method, and 53° 24′ 46″·45 by the second method. The position from which the transits over the prime vertical were taken is six feet south of the meridian transit instrument.

*Latitude of the Liverpool Observatory, deduced from Transits over the Prime Vertical.**

Date.	Name of Star.	Illuminated End of Transit Axis.	Vertical.	Hour Angle observed.	Azimuthal Deviation Correction.	Level Correction.	Collimation Correction.	Co-Latitude.
1844.				° ′ ″	″		″	° ′ ″
Dec. 20	ζ Cygni	S	W	65 2 40·35	−61·31	−0·64	+3·07	36 35 13·44
	Capella	...	E	40 10 52·20	+24·09	...	...	11·86
	β Aurigæ	...	E	42 15 34·95	+25·92	...	...	11·35
	β Geminor.	...	E	66 21 41·85	+65·14	...	...	13·43
	α² Geminor.	...	E	62 7 31·35	+53·92	...	...	11·99
	ε Leonis	...	E	70 15 48·60	+79·46	...	...	11·32
	α Persei	...	W	30 18 18·75	−16·68	...	...	12·16
30	β Tauri	N	E	66 15 15·45	−31·75	−0·22	−3·07	11·35
	α Persei	...	E	30 18 20·85	− 8·34	−0·06	...	13·69
	ζ Cygni	...	W	65 4 9·30	+30·96	+0·14	...	11·26
	Capella	...	E	40 9 6·75	−12·87	+0·92	...	11·57
	β Geminor.	...	E	66 20 6·30	−37·38	+1·87	...	11·67
	α² Geminor.	...	E	62 5 51·45	−31·12	+2·07	...	13·83
1845. Jan. 11	α Persei	S	E	30 18 40·20	−10·56	+2·02	+3·55	13·74
	Capella	...	E	40 9 15·60	−15·24	+2·96	...	12·87
	β Geminor.	...	E	66 20 11·25	−41·24	+3·30	...	10·25
	α Androm.	...	W	66 31 4·80	+41·57	+3·42	...	10·38
	α Persei	...	W	30 20 3·60	+10·56	+3·80	...	13·30
	ι Ursæ Maj.	...	E	32 30 51·90	−11·50	+4·22	...	13·17
12	α Cygni	N	W	42 40 20·40	+26·23	−0·56	−3·55	14·32
	β Tauri	...	E	66 14 43·35	−64·69	−0·70	...	12·06
	α Persei	...	E	30 17 41·85	−16·63	−0·80	...	14·14
	ζ Cygni	...	W	65 4 39·90	+61·22	+0·03	...	12·56
	Capella	...	E	40 8 33·00	−24·94	+0·07	...	10·26
	α² Geminor.	...	E	62 5 25·80	−55·83	+0·73	...	9·67
	α Androm.	...	W	66 31 20·70	+68·04	+0·94	...	9·88
	α Persei	...	W	30 19 54·00	+17·30	+1·78	...	13·70
18	β Tauri	S	E	66 15 7·35	−49·28	+0·69	+3·55	9·64
	α Persei	...	E	30 18 27·00	−12·67	...	...	13·77
	ζ Cygni	...	W	65 4 37·65	+46·63	...	...	9·62
	α Persei	...	W	30 19 54·00	+12·68	...	...	36 35 14·76

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* The original of the annexed table contained a column exhibiting the uncorrected co-latitude, which has been omitted for want of space.

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Date.	Name of Star.	Illuminated End of Transit Axis.	Vertical.	Hour Angle observed.	Azimuthal Deviation Correction.	Level Correction.	Collimation Correction.	Co-Latitude.
1845.				° ′ ″	″		″	° ′ ″
Jan. 22	β Tauri	N	E	66 14 30·60	−79·11	−0·35	−3·55	36 35 11·42
	α Persei	...	E	30 17 30·00	−20·34	...	...	13·66
	ζ Cygni	...	W	65 4 56·40	+74·89	...	...	11·42
	α Persei	...	W	30 20 0·75	+20·36	...	...	12·19
30	β Draconis	S	E	15 18 55·80	− 9·63	+3·52	+2·73	12·14
	γ Draconis	...	E	21 0 44·10	−13·51	+1·78	...	10·32
	α Cygni	...	E	42 38 46·65	−32·40	+2·38	...	11·41
	β Draconis	...	W	15 21 19·80	+ 9·66	+1·78	...	10·81
31	12 Can.Ven.	N	W	52 50 5·25	+37·82	−0·43	−2·73	10·25
	β Draconis	...	E	15 18 17·70	− 7·85	−0·44	...	11·98
	γ Draconis	...	E	21 0 7·95	−11·01	−0·44	...	12·02
	α Cygni	...	E	42 38 45·15	−26·42	+0·69	...	11·36
Feb. 4	α Cygni	N	E	42 39 3·00	−16·23	−1·48	−2·73	12·56
	γ Draconis	...	W	21 1 42·30	+ 6·77	−1·48	...	12·56
6	12 Can.Ven.	S	W	52 49 30·30	+13·05	−0·85	+2·73	12·49
	β Draconis	...	E	15 19 37·95	− 2·71	...	...	12·97
	γ Draconis	...	E	21 1 20·10	− 3·80	...	...	12·49
April 7	Capella	N	W	40 9 33·60	+ 4·37	+0·21	−4·09	13·85
	θ Ursæ Maj.	...	E	15 35 12·00	− 1·41	...	...	12·64
	12 Can.Ven.	...	E	52 48 34·95	− 6·83	...	...	13·86
	θ Ursæ Maj.	...	W	15 35 29·40	+ 1·45	...	...	13·18
	η Ursæ Maj.	...	W	27 27 17·55	− 2·69	...	...	12·98
8	Capella	S	W	40 9 49·95	+ 1·11	+1·30	+4·09	13·25
	θ Ursæ Maj.	...	E	15 36 23·10	− 0·37	...	...	13·32
	12 Can.Ven.	...	E	52 48 57·75	− 1·74	...	...	13·25
	θ Ursæ Maj.	...	W	15 36 29·85	+ 0·37	...	...	13·17
	η Ursæ Maj.	...	E	27 27 59·85	− 0·69	...	...	36 35 13·45

Hence mean value of co-latitude $= 36^\circ\ 35'\ 12''\!\cdot 28$
and latitude .... $= 53\ 24\ 47\cdot 72$

Liverpool Observatory, 1853, *May* 31.

At the meeting of the Society, held on the 13th of May, a letter was read which Captain Manners had recently received from Mr. Wackerbarth of Upsala, containing information respecting the present state of astronomy in Sweden, and also some interesting particulars relative to the ancient observatory of Tycho Brahé in the Island of Huena.